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14. ABSTRACT

The goals of the proposed work are an initial feasibility study, including calculations, demonstrating the ability to direct or focus low-frequency acoustic energy. For given source configurations, acoustic propagation modeling was conducted for simple, idealized, harbor type environments. The calculations yielded spatial plots of acoustic energy as a function of depth and range which provide information on source location and power requirements.

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free-field source modeling, modeling capability, acoustic propagation models, real time harbor conditions data

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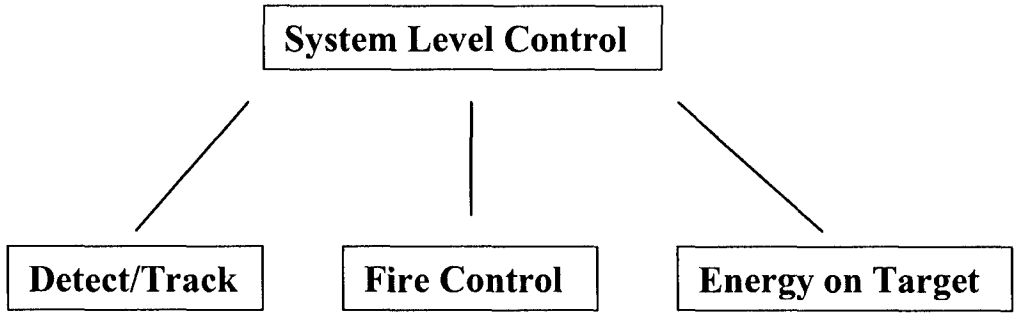
Long-term Objectives

The long-term objective of this proposal is to develop a harbor/mooring area defense concept that responds to threats posed by covert swimmers. The general concept is to hail, deter, and/or incapacitate the swimmer by directing a controlled level of low-frequency acoustic energy at the target location. At the system level, the concept requires combining elements of target detection/tracking, localized fire control to focus the acoustic energy using emplaced acoustic sources, and sources capable of delivering energy commensurate with the extant defense requirements. The system is represented in the block diagram of Fig. 1.

FIGURE 1. Harbor Defense System



Goals of the present proposal

The goals of the proposed work are an initial feasibility study, including calculations, demonstrating the ability to direct or focus low-frequency acoustic energy. For given source configurations, acoustic propagation modeling is to be conducted for simple, idealized, harbor type environments. The calculations yield spatial plots of acoustic energy as a function of depth and range which can provide information on source location and power requirements.

Approach

The approach is to begin with a literature search into different source configurations which might be considered for focusing low-frequency sound. Candidate source configurations will then be modeled and their free-space directivity compared qualitatively. Different source configurations will be used for modeling the acoustic field in simple waveguide environments.

Work Completed

A literature and supplier search was conducted to explore state of the art source concepts for creating focused acoustic fields including Super-directive [1] and parametric [2] source configurations.

A literature search conducted for determining the bio-effects of low frequency acoustic fields on humans [3].

Free-field source modeling comparing directivity of a dipole source and super-directive array of sources to a point source. Qualitative results were provided to the program manager under separate cover.

Computing platform specified and purchased for dedicated modeling capability. Mode, PE, and Wavenumber Integration acoustic propagation models obtained and installed.

Dialog started with Gary Koopman and associate co-PIs to begin information exchange regarding proposed source capabilities (to be provided by Koopman) and power and control requirements for directing acoustic energy (as determined by our modeling).

Handbook of design requirements for Military Harbors acquired to give guidance on Harbor types, configurations, and typical mooring and berthing criteria that must be considered in the acoustic modeling.

Stand alone military harbor (Mayport, FL) and example large commercial port (Long Beach, CA) identified and classified using above document.

Initial propagation studies conducted for waveguide with properties obtained for Mayport, FL.

Potential sources of input data for acoustic modeling identified, including real time harbor conditions data from PORTS [4], USGS, and COMINEWARCOM.

Results

Dipole and array sources comprised of multiple point sources that were phase and amplitude shaded were modeled and shown to achieve directivity of the major lobe. Three-dimensional plots of the 180 dB contour for the different source configurations were generated illustrating directivity.

Super-directive source was inserted into simple waveguide acoustic model and shown to focus energy in depth bands over range. This result contrasted with the point source model for the same environment which was dominated by a two-mode interference pattern.

Initial modeling for the Mayport, FL site showed that a full elastic waveguide model [5] is required to account for the shear properties of the underlying limestone basement.

Impact/Applications

This work seeks to provide a means of protection for ships in busy harbors and mooring sites by deterrence or incapacitation of the threat posed by unfriendly swimmers.

Related Projects

This work is a component of a Future Naval Capability (FNC) Project on underwater threat neutralization for defense of harbor and near-shore naval infrastructure. The goal of the FNC is to demonstrate a prototype harbor defense system in a operational environment in 2008. Collaborators include Gary Koopman (PSU/CAV), Eric Will (BAE Systems), Bruce Abraham (Applied Physical Sciences, Inc.), Mark Hamilton (ARL/UT), and Peter Matic (NRL).

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